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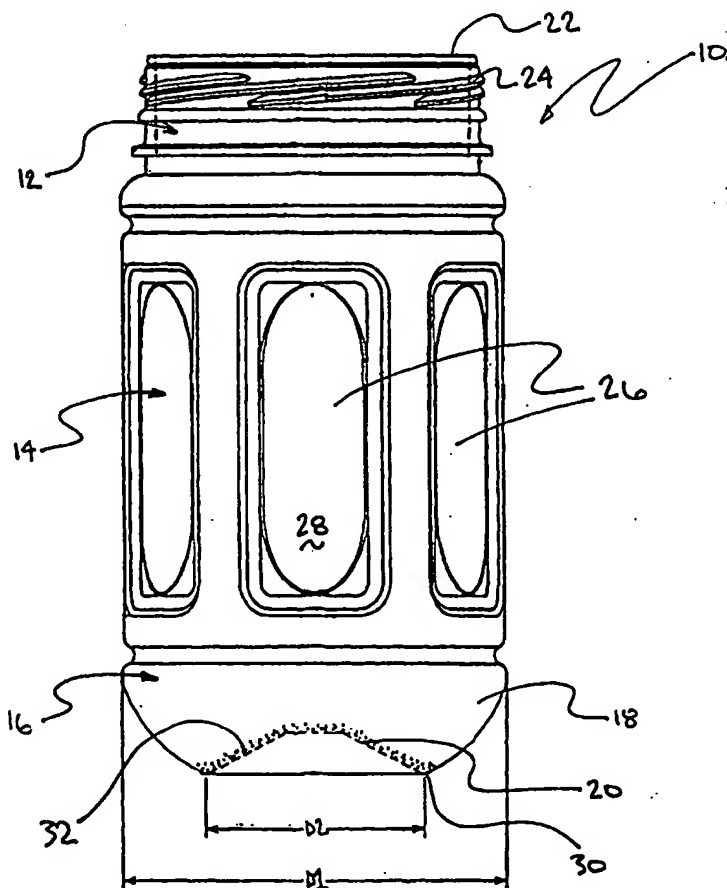
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[Continued on next page]

(54) Title: **BASE PORTION OF A PLASTIC CONTAINER**



(57) Abstract: A plastic container (10) for receiving a commodity and retaining the commodity during high-temperature pasteurization and subsequent cooling that includes an upper portion (12), a sidewall portion (14), and a base portion (16). The upper portion (12) defines an aperture (22) and is sealable with a closure. The sidewall portion (14), which defines a sidewall diameter (D1), is connected to and extends generally downward from the upper portion (12). The base portion (16) has a chime section (18) connected to and extending generally downward and inward from the sidewall portion (14), and a push-up section (20) connected to and extending generally upward and inward from the chime section (18) to close the plastic container (10). The push-up section (20) defines a push-up diameter (D2), and the ratio of the sidewall diameter (D1) to the push-up diameter (D2) is at least 1.3:1.0.

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BASE PORTION OF A PLASTIC CONTAINER

TECHNICAL FIELD OF THE INVENTION

This invention generally relates to plastic containers. More specifically, this invention relates to base portions of plastic containers for receiving a commodity and retaining the commodity during high-temperature pasteurization and during subsequent cooling, shipment, and use of the plastic containers.

5

BACKGROUND

Recently, manufacturers of polyethylene terephthalate (PET) containers have begun to supply plastic containers for commodities that were previously packaged in glass containers. The manufacturers, as well as consumers, have
10 recognized that PET containers are lightweight, inexpensive, recyclable, and manufacturable in large quantities. Manufacturers currently supply PET containers for various liquid commodities, such as juices. They also desire to supply PET containers for solid commodities, such as pickles. Many solid commodities, however, require pasteurization or retort, which presents an
15 enormous challenge for manufactures of PET containers.

Pasteurization and retort are both methods for sterilizing the contents of a container after it has been filled. Both processes include the heating of the contents of the container to a specified temperature, usually above 70°C, for a duration of a specified length. Retort differs from pasteurization in that it also
20 applies overpressure to the container. This overpressure is necessary because a hot water bath is often used and the overpressure keeps the water in liquid form

above its boiling point temperature. These processes present technical challenges for manufactures of PET containers, since new pasteurizable and retortable PET containers for these commodities will have to perform above and beyond the current capabilities of conventional heat set containers. Quite simply, the PET containers of the current techniques in the art cannot be produced in an economical manner such that they maintain their material integrity during the thermal processing of pasteurization and retort.

PET is a crystallizable polymer, meaning that it is available in an amorphous form or a semi-crystalline form. The ability of a PET container to maintain its material integrity is related to the percentage of the PET container in crystalline form, also known as the "crystallinity" of the PET container. Crystallinity is characterized as a volume fraction by the equation:

$$\text{Crystallinity} = \frac{\rho - \rho_a}{\rho_c - \rho_a}$$

where ρ is the density of the PET material; ρ_a is the density of pure amorphous PET material (1.333 g/cc); and ρ_c is the density of pure crystalline material (1.455 g/cc). The crystallinity of a PET container can be increased by mechanical processing and by thermal processing.

Mechanical processing involves orienting the amorphous material to achieve strain hardening. This processing commonly involves stretching a PET container along a longitudinal axis and expanding the PET container along a transverse axis. The combination promotes biaxial orientation. Manufacturers of

PET bottles currently use mechanical processing to produce PET bottles having roughly 20% crystallinity (average sidewall crystallinity).

Thermal processing involves heating the material (either amorphous or semi-crystalline) to promote crystal growth. Used by itself on amorphous material, thermal processing of PET material results in a spherulitic morphology that interferes with the transmission of light. In other words, the resulting crystalline material is opaque (and generally undesirable as the sidewall of the container). Used after mechanical processing, however, thermal processing results in higher crystallinity and excellent clarity. The thermal processing of an oriented PET container, which is known as heat setting, typically includes blow molding a PET preform against a heated blow mold, at a temperature of 120 – 130°C, and holding the blown container for about 3 seconds. Manufacturers of PET juice bottles, which must be hot filled at about 85°C, currently use heat setting to produce PET juice bottles having a range of up to 25-30% crystallinity. Although these hot fill PET containers exhibit a significant improvement over the non-hot fill PET containers, they cannot maintain their material integrity during the thermal processing of pasteurization and retort, especially in their base portion, which, until now, have exhibited a roll-out failure.

Thus, the manufacturers of PET containers desire a container design that maintains its material integrity during subsequent pasteurization or retort of the contents within the PET container, and during subsequent cooling, shipment, and use of the PET containers. It is therefore an object of this invention to provide such a PET container that overcomes the problems and disadvantages of the conventional techniques in the art.

SUMMARY OF THE INVENTION

Accordingly, this invention provides for a plastic container having a particular base portion that allows the PET container to maintain its material integrity during subsequent mild pressures (35 to 175 kPa) encountered during high-temperature pasteurization or retort of the contents within the PET container, and during subsequent cooling, shipment, and use of the PET container. As used herein, "high-temperature" pasteurization and retort are pasteurization and retort processes in which the plastic container is exposed to temperatures greater than about 80°C.

At its broadest, the invention is a plastic container for receiving a commodity and retaining the commodity during high-temperature pasteurization and subsequent cooling that includes an upper portion, a sidewall portion, and a base portion. The upper portion defines an aperture and is sealable with a closure. The sidewall portion, which defines a sidewall diameter, is connected to and extends generally downward from the upper portion. The base portion has a chime section connected to and extending generally downward and inward from the sidewall portion, and a push-up section connected to and extending generally upward and inward from the chime section to close the plastic container. The push-up section defines a push-up diameter, and the ratio of the sidewall diameter to the push-up diameter is at least 1.3:1.0.

Further features and advantages of the invention will become apparent from the following discussion and accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side view of the plastic container of the preferred embodiment of the invention; and

FIGURE 2 is a view of the projected areas of the sidewall and the push-up
5 of the preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description of the preferred embodiment is merely exemplary in nature, and is in no way intended to limit the invention or its application or
10 uses.

As shown in FIGURE 1, a plastic container 10 of the preferred embodiment of the invention includes an upper portion 12, a sidewall portion 14, and a base portion 16 having a chime section 18 and a push-up section 20. Although the plastic container 10 has been specifically designed for receiving a
15 commodity and retaining the commodity during high-temperature pasteurization or retort, the plastic container 10 may be used for receiving a commodity and retaining the commodity during other thermal processes, such as a hot-fill process. Further, although the plastic container 10 has been specifically designed to be made with a PET material, the plastic container 10 may be made
20 with other suitable plastic materials.

The upper portion 12 of the preferred embodiment of the invention defines an aperture 22. The aperture 22 preferably has a 63-82mm diameter, which qualifies as a "wide mouth" container, but may alternatively have other suitable diameters. The upper portion 12 of the preferred embodiment of the invention is

sealable with a closure (not shown). In the preferred embodiment, the upper portion 12 includes a threaded finish 24 that engages with a threaded closure (not shown). In an alternative embodiment, the upper portion 12 may include a ridge or flange that engages with a snap closure.

5 The sidewall portion 14 of the preferred embodiment of the invention is connected to and extends generally downward from the upper portion 12. The sidewall portion 14 preferably includes several panels 26, but may alternatively include smooth or ribbed surfaces, a grip surface, a label surface, or any combination of these or other suitable surfaces. The sidewall portion 14 of the
10 preferred embodiment of the invention defines a sidewall diameter D1. In the preferred embodiment, the sidewall diameter D1 is substantially constant from the upper region of the sidewall portion 14 to the lower region of the sidewall portion 14. In alternative embodiments, where the sidewall diameter D1 is not substantially constant, the sidewall portion 14 defines a sidewall projected area
15 27, taken along a horizontal plane at the middle of the sidewall portion 14 (as shown in FIGURE 2).

 The base portion 16 and chime section 18 of the preferred embodiment of the invention is connected to and extends generally downward and inward from the sidewall portion 14. The chime section 18 preferably has a concave shape
20 relative to and when viewed from an interior portion 28 of the plastic container 10, but may alternatively have a truncated-cone shape, a convex shape, or any other suitable shape. The push-up section 20 of the preferred embodiment of the invention is connected to and extends generally upward and inward from the lowermost portion of the chime section 18 to close the plastic container 10. The

push-up section 20 preferably has a truncated-cone shape, but may alternatively have a concave shape, a convex shape, or any other suitable shape. In the preferred embodiment, the region where the chime section 18 joins to the push-up section 20 defines a sharp transition 30. As used herein, a transition is

5 considered sharp when the transition forms a hard corner as opposed to a soft or rounded corner. In other words, the transition is not blended or smoothed by an intentionally formed radius in the transition. Generally in container formation, sharp corners or transitions are avoided. In alternative embodiments, the chime section 18 and the push-up section 20 may define a rounded transition with a

10 significant radius. The outboardmost portion of the push-up section 20, at the sharp transition 30 between the chime section 18 and the push-up section 20, defines a push-up diameter D2. In the preferred embodiment of the invention, the sharp transition 30 between the chime section 18 and the push-up section 20 defines a substantially constant push-up diameter D2 about a central axis of the

15 plastic container 10. Further, in the preferred embodiment of the invention, the sharp transition 30 between the chime section 18 and the push-up section 20 is substantially constant along the axis of the plastic container 10. In other words, the entire surface of the sharp transition 30 between the chime section 18 and the push-up section 20 defines a contact ring which would rest upon a table

20 surface if the plastic container 10 was placed in an upright position on the table surface. In an alternative embodiment, the sharp transition 30 between the chime section 18 and the push-up section 20 may vary about the axis and along the axis. In this situation, the outboardmost portion of the push-up section 20, at

the sharp transition 30 between the chime section 18 and the push-up section 20, would define a push-up projected area 31 (as shown in FIGURE 2).

The ratio of the sidewall diameter D1 to the push-up diameter D2 of the preferred embodiment of the invention is at least 1.3:1.0. More preferably, the
5 ratio of the sidewall diameter D1 to the push-up diameter D2 is 1.5:1.0, but the ratio may alternatively be less than or greater than this preferred ratio. Further, for those embodiments of the invention with a non-circular sidewall, the sidewall projected area 27 is 70% greater than the push-up projected area 31. More preferably, the sidewall projected area 27 is 125% greater than the push-up
10 projected area 31, but the difference may alternatively be less than or greater than this preferred difference.

After initial blow molding of the container 10, by utilizing the above base geometry, the push-up 20 is substantially comprised of material which has not been oriented as a result of the stretching and blowing of a preform into the
15 container 10. In this non-oriented area of the base portion 16, spherulitic crystallization is imparted. Since pasteurization and retort processes will subject the container to temperatures above the material's glass transition temperature, the high crystallinity levels in the push-up 20 operate to ensure the stability of the base portion 16. It is further noted that the non-oriented material may be
20 confined entirely to the push-up 20, may terminate at the transition 30, or may even extend to the chime portion 18. In the latter situation, the spherulitically crystallized non-oriented material is generally confined to the lowermost regions of the chime portion 18, adjacent to the transition 30, as seen in Figure 1.

The push-up 20 of the base portion 16 of the preferred embodiment of the invention has an average crystallinity of at least 20%. This feature of the push-up 20, together with the ratio of the sidewall diameter D1 to the push-up diameter D2 and the sharp transition 30, allows the plastic container 10 to maintain its material and structural integrity during subsequent high-temperature pasteurization or retort of the commodity within the plastic container 10, during the resultant pressure increases, and during subsequent cooling, shipment, and use of the plastic container 10 without any distortion of the geometry of the base during the process of the base portion 16. A portion of the push-up 20 of the base portion 16 may have an average density of 1.370 g/cc (roughly corresponding to 30%), 1.375 g/cc (roughly corresponding to 34.4% crystallinity), and even 1.380 g/cc (roughly corresponding to 38.5% crystallinity). The push-up 20 of the base portion 16 may alternatively have a crystallinity of at least 30% along a portion of the interior surface 32, which may be significantly greater than the average crystallinity of the push-up 20. The interior surface 32, as defined by the first 10% of the push-up 20, may have a crystallinity of 35%, 40%, or even 45%.

The average density and the average crystallinity of the push-up 20 of base portion 16 of the plastic container 10 is preferably achieved with the blow molding machine and method described in U.S. patent application no. (Attorney docket no. 8330-000203), which is hereby incorporated in its entirety by this reference, but may alternatively be achieved with other suitable machines and methods. The blow molding machine and method preferably induces the crystallinity of the push-up 20 of the base portion 16 by applying heat from a mold and by applying heat from the interior portion 28 of the plastic container 10.

More specifically, the method uses convection heat transfer by circulating a high-temperature fluid through the interior portion 28 of the plastic container 10. By using this blow molding machine and method, together with the ratio of the sidewall diameter D1 to the push-up diameter D2, a plastic container 10 that
5 maintains its material integrity during subsequent high-temperature pasteurization and retort, and during subsequent cooling, shipment, and use, may be efficiently and effectively provided.

The foregoing discussion discloses and describes a preferred embodiment of the invention. One skilled in the art will readily recognize from such
10 discussion, and from the accompanying drawings and claims, that changes and modifications can be made to the invention without departing from the true spirit and fair scope of the invention as defined in the following claims.

We claim:

1. A plastic container for receiving a commodity, said plastic container comprising:
 - an upper portion defining an aperture and sealable with a closure;
 - a sidewall portion connected to and extending generally downward
 - 5 from said upper portion, said sidewall portion defining a sidewall diameter; and
 - a base portion having a chime section connected to and extending generally downward and inward from said sidewall portion, and a push-up section connected to and extending generally upward and inward from said chime section to close said plastic container, said push-up section defining a push-up
 - 10 diameter, said sidewall diameter being at least 30% greater than said push-up section diameter, said push-up section having a portion with a crystallinity of at least 20%.
2. The plastic container of Claim 1 wherein said portion of said push-up section has a crystallinity of at least 25%.
3. The plastic container of Claim 1 wherein said portion of said push-up section has a crystallinity of at least 30%.
4. The plastic container of Claim 1 wherein said portion of said push-up section has a crystallinity of at least 35%.

5. The plastic container of Claim 1 wherein said push-up section exhibits spherulitic crystallization.

6. The plastic container of Claim 1 wherein a portion of said chime section exhibits spherulitic crystallization.

7. The plastic container of Claim 6 wherein said portion of said chime section is a lowermost region thereof adjacent to said push-up section.

8. The plastic container of Claim 1 wherein said push-up section and a portion of said chime section exhibits spherulitic crystallization.

9. The plastic container of Claim 1 wherein said chime section and said push-up section merge together at a sharp transition.

10. The plastic container of Claim 1 wherein said sidewall diameter is at least 50% greater than said push-up diameter.

11. The plastic container of Claim 1 wherein said sidewall diameter is at least 70% greater than said push-up diameter.

12. A plastic container for receiving a commodity, said plastic container comprising:

an upper portion defining an aperture and sealable with a closure;

a sidewall portion connected to and extending generally downward
5 from said upper portion, said sidewall portion defining a sidewall projected area;
and

a base portion having a chime section connected to and extending
generally downward and inward from said sidewall portion, and a push-up section
connected to and extending generally upward and inward from said chime
10 section to close said plastic container, said push-up section defining a push-up
projected area and having a portion with an interior surface, said sidewall
projected area being at least 70% greater than said push-up projected area, said
interior surface having a crystallinity of at least 30%.

13. The plastic container of Claim 12 wherein said interior surface has a
crystallinity of at least 35%.

14. The plastic container of Claim 12 wherein said interior surface has a
crystallinity of at least 40%.

15. The plastic container of Claim 12 wherein said interior surface has a
crystallinity of at least 45%.

16. The plastic container of Claim 12 wherein said chime section and said push-up section merge together at a sharp transition.

17. The plastic container of Claim 12 wherein said sidewall projected area is at least 125% greater than said push-up projected area.

18. The plastic container of Claim 12 wherein said sidewall projected area is at least 190% greater than said push-up projected area.

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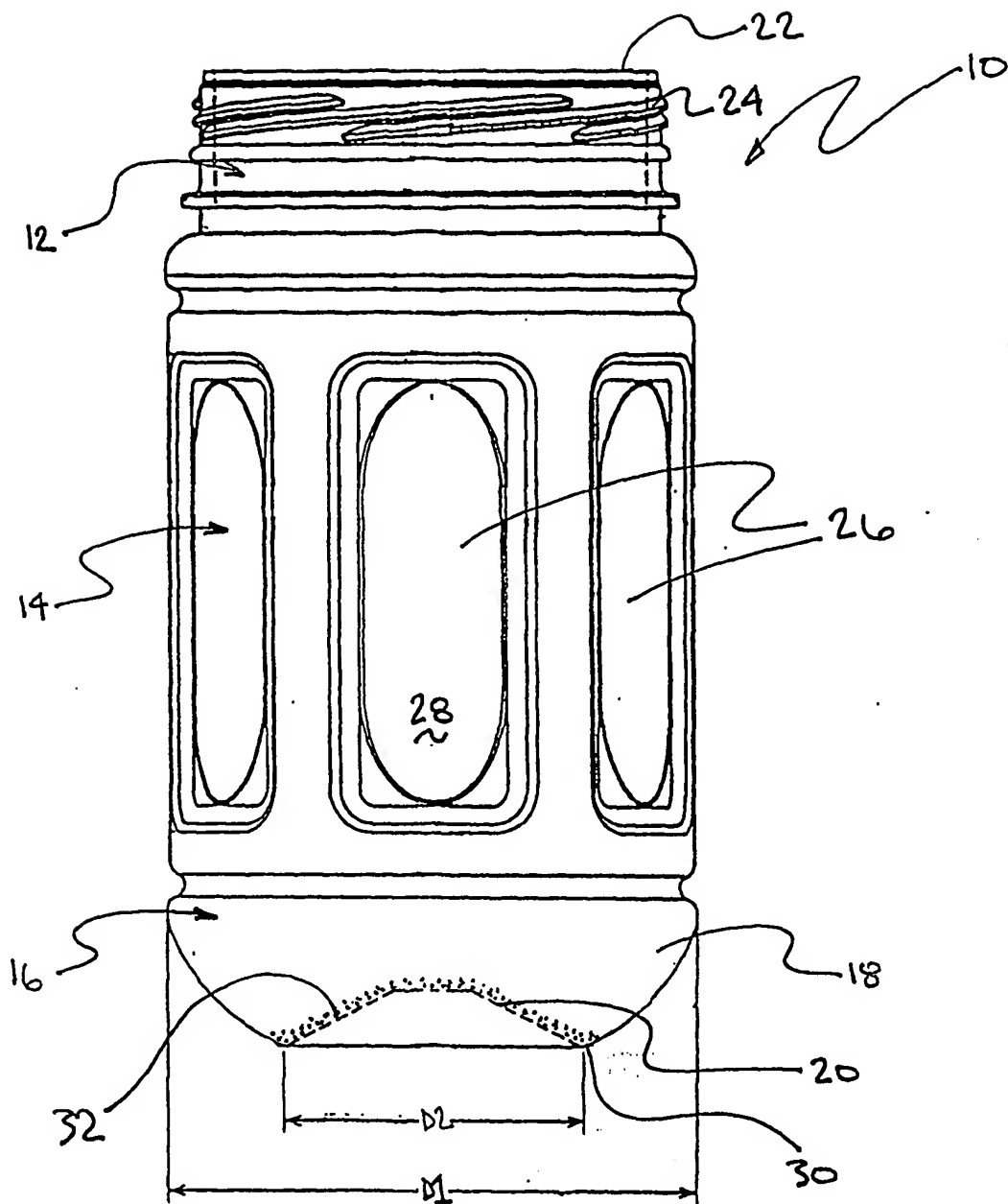


FIG. 1

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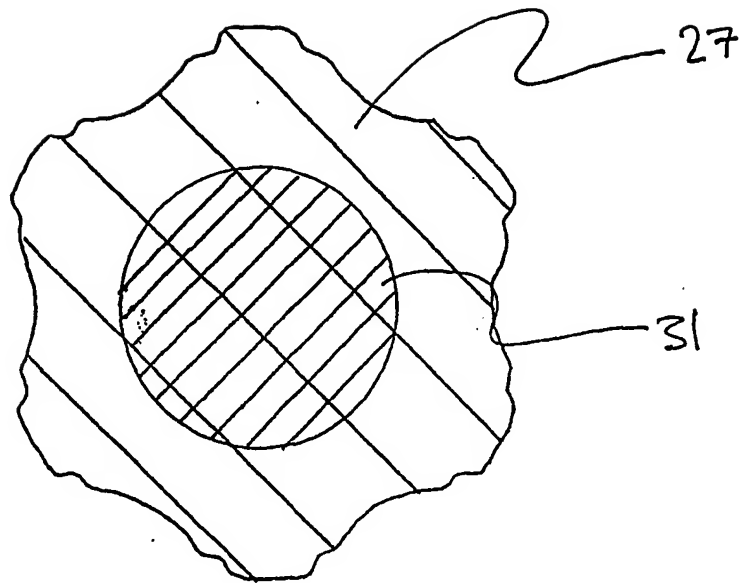


FIG. 2

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 B65D1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 0 731 030 A (MITSUI PETROCHEMICAL IND) 11 September 1996 (1996-09-11) page 3, line 9 - line 20 table 2 figure 1	1-4,6,7
Y	---	5,8-11
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 735 420 A (IKEGAMI HIROO ET AL) 7 April 1998 (1998-04-07) column 18, line 16 -column 22, line 22 table 1 figures 1-12	12-18
Y		5,8-11
A		1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/21006

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